Name: KEY P: ____ Date: ____

Unit IV: Refraction Review

The Speed of Light

1) The star Sirius is 8.7 light years away. What does this mean?

Light takes 8.7 years to get from Sirius to us.

2) How long would it take a phone call to reach Mars? Earth and Mars are 8.0×10^{10} m apart.

$v = 3.00 \times 10^8$ m/s
$d = 8.0 \times 10^{10}$ m
$t = ?$

$v = \frac{d}{t}$

$t = \frac{d}{v}$

$t = \frac{8.0 \times 10^{10}\ m}{3.00 \times 10^8\ m/s}$

$t \approx 270\ s$

3) The international space station has an orbit 278 km above the Earth's surface. If they are watching live T.V. in the station, how long is their delay? Assume their T.V. signal is sent via radio waves.

$t = ?$
$d = 278\ km = 278000\ m$
$v = 3.00 \times 10^8$ m/s

$v = \frac{d}{t}$

$t = \frac{d}{v}$

$t = \frac{278000\ m}{3.00 \times 10^8\ m/s}$

$t \approx 9.27 \times 10^{-4}\ s$

$t \approx 0.000927\ s$

4) How many parsecs away is a galaxy if it takes 5.00×10^{10} s to reach us? Find this distance in meters first.

$t = 5.00 \times 10^{10}\ s$
$v = 3.00 \times 10^8$ m/s
$d = ?$

$v = \frac{d}{t}$

$d = vt$

$d = (5.00 \times 10^{10}\ s)(3.00 \times 10^8\ m/s)$

$d = 1.50 \times 10^{19}\ m$

$d \approx 486\ pc$

$1.50 \times 10^{19}\ m \left(\frac{1\ ly}{9.46 \times 10^{15}\ m}\right)\left(\frac{1\ pc}{3.26\ ly}\right)$

5) How many astronomical units away from Earth is the planet Jupiter if it takes sunlight 2594 s to reach it?

$d = ?$
$v = 3.00 \times 10^8$ m/s
$t = 2594\ s$

$v = \frac{d}{t}$

$d = vt$

$d = (3.00 \times 10^8\ m/s)(2594\ s)$

$d = 7.782 \times 10^{11}\ m$

$d \approx 5.19\ AU$

$7.782 \times 10^{11}\ m \left(\frac{1\ AU}{1.50 \times 10^{11}\ m}\right)$

Name:_____ P:_____ Date:_____

Refraction

1) What is the speed of light in water?

$c = 3.00 \times 10^8$ m/s
$n = 1.33$
$v = ?$

$n = \frac{c}{v}$

$v = \frac{c}{n}$

$v = \frac{3.00 \times 10^8 \text{ m/s}}{1.33}$

$v \simeq 2.26 \times 10^8$ m/s

2) The speed of light is measured at 2.19×10^8 m/s. What substance is the light travelling in?

$v = 2.19 \times 10^8$ m/s
$c = 3.00 \times 10^8$ m/s
$n = ?$

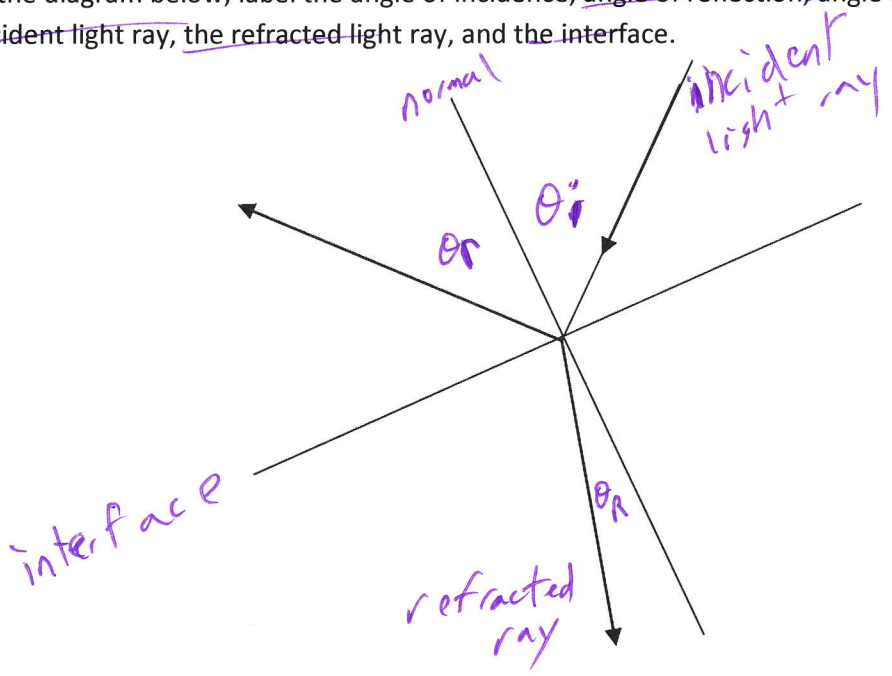
$n = \frac{c}{v}$

$n = \frac{3.00 \times 10^8 \text{ m/s}}{2.19 \times 10^8 \text{ m/s}}$

$n \simeq 1.37$

Ethyl Alcohol

3) In the diagram below, label the angle of incidence, angle of reflection, angle of refraction, normal, the incident light ray, the refracted light ray, and the interface.



4) A beam of light from carbon tetrachloride enters oleic acid. If the angle of incidence is 86°, what is the angle of refraction?

$n_1 = 1.46$
$\theta_1 = 86°$
$n_2 = 1.46$
$\theta_2 = ?$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\frac{n_1 \sin\theta_1}{n_2} = \sin\theta_2$

$\frac{1.46 \sin 86°}{1.46} = \sin\theta_2$

$\theta_2 \simeq 86°$

Name:_____ P:_____ Date:_____

5) An unknown substance has an incident ray of light with an angle of 26.0°. If the angle of refraction in crown glass is 24.4°, what is the unknown substance?

$n_1 = ?$
$\theta_1 = 26.0°$
$n_2 = 1.52$
$\theta_2 = 24.4°$

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

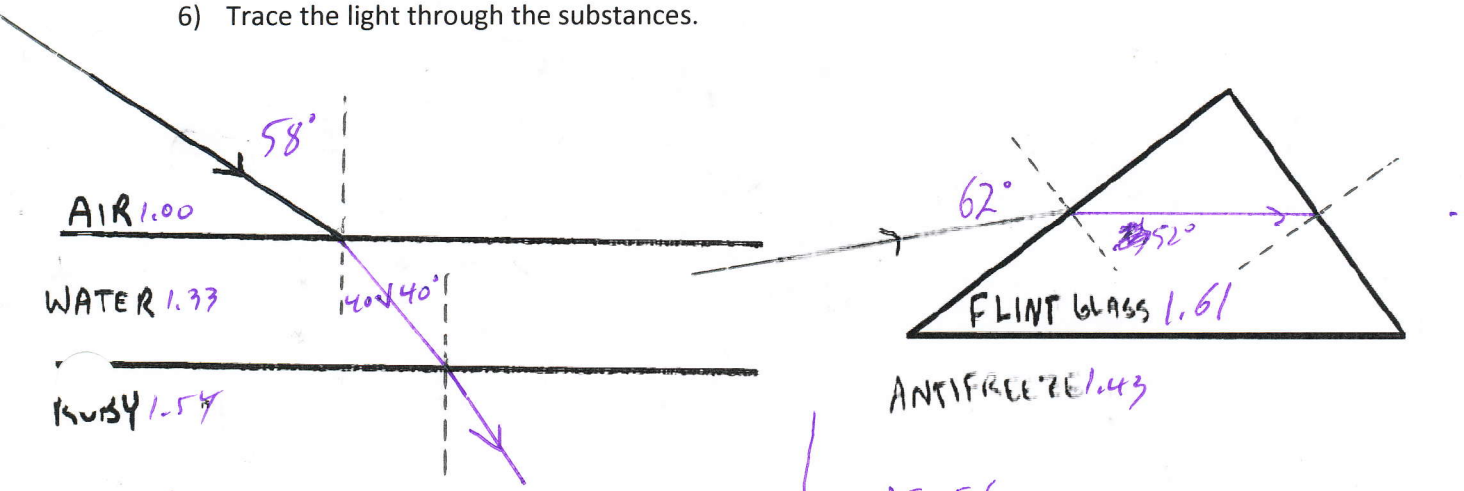
$n_1 = \frac{n_2 \sin\theta_2}{\sin\theta_1}$

$n_1 = \frac{1.52 \sin 24.4°}{\sin 26.0°}$

$n_1 \approx 1.43$

Antifreeze

6) Trace the light through the substances.



Air–Water

$\sin\theta_2 = \frac{1 \sin 58°}{1.33}$

$\theta_2 = 40°$

Water → Ruby

$\sin\theta_2 = \frac{1.33 \sin 40°}{1.54}$

$\theta_2 \approx 34°$

AF–FG

$\sin\theta_2 = \frac{1.43 \sin 62°}{1.61}$

$\theta_2 \approx 52°$

7) Light travels from zircon into fused quartz. What is the critical angle?

$n_1 = 1.92$
$n_2 = 1.46$
$\theta_c = ?$

$\sin\theta_c = \frac{n_2}{n_1}$

$\sin\theta_c = \frac{1.46}{1.92}$

$\theta_c \approx 49.5°$

Name:_____ P:____ Date:_____

Photometry

1) A bulb has a luminous flux of 2400 lm. Determine the illuminance of a book that is 1.50 m away from the light source.

$E = ?$
$P = 2400\ lm$
$r = 1.50\ m$

$E = \frac{P}{4\pi r^2}$

$E = \frac{2400\ lm}{4\pi (1.50\ m)^2}$

$E \approx 85\ lx$

2) How far away is an object from a light source if a 2850 lm bulb gives the object an illumination of 45.0 lx?

$r = ?$
$P = 2850\ lm$
$E = 45.0\ lx$

$E = \frac{P}{4\pi r^2}$

$r^2 = \frac{P}{4\pi E}$

$r = \pm\sqrt{\frac{P}{4\pi E}}$

$r = +\sqrt{\frac{2850\ lm}{4\pi (45.0\ lx)}}$

$r \approx 2.24\ m$

3) A street lamp with a luminous intensity of 510 cd is placed 7.00 m above the ground. Find the luminous flux and the illuminance at the ground.

$I = 510\ cd$
$d = 7.00\ m$
$E = ?$
$P = ?$

$E = \frac{I}{d^2}$

$E = \frac{510\ cd}{(7.00\ m)^2}$

$E \approx 1.0 \times 10^1\ lx$

$I = \frac{P}{4\pi}$

$I 4\pi = P$

$(510\ cd)(4)(\pi) = P$

$6400\ lm \approx P$

4) A 35.0 cd source placed 2.00 m from a light meter gives the same illumination as an unknown source placed 4.25 m from the meter. Determine the intensity of the unknown source.

$I_1 = 35.0\ cd$
$d_1 = 2.00\ m$
$E_1 = E_2$
$d_2 = 4.25\ m$
$I_2 = ?$

$\frac{I_1}{d_1^2} = \frac{I_2}{d_2^2} \Rightarrow \frac{I_1 d_2^2}{d_1^2} = I_2$

$\frac{(4.25\ m)^2 (35.0\ cd)}{(2.00\ m)^2} = I_2$

$I_2 \approx 158\ cd$